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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/642,607	08/19/2003	Brian A. Vaartstra	M4065.0133/P133-B	2821

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DICKSTEIN SHAPIRO MORIN & OSHINSKY LLP
2101 L STREET NW
WASHINGTON, DC 20037-1526

EXAMINER	
NOVACEK, CHRISTY L	

ART UNIT	PAPER NUMBER
2822	

DATE MAILED: 07/28/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/642,607	VAARTSTRA ET AL.	
	Examiner	Art Unit	
	Christy L. Novacek	2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 August 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *75-91* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *75-91* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *8/19/03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This office action is in response to the preliminary amendment filed August 19, 2003.

Claim Objections

Claim 89 is objected to because of the following informalities: Lines 9-11 of claim 89 recite the limitation of "said chamber". There is insufficient antecedent basis for this limitation in the claim. Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 81 and 91 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 81 is dependent upon claim 76. Claim 76 recites the limitation of "a single gas serves as said titanium precursor and said nitrogen precursor". However, claim 81 recites the limitation of the titanium precursor being "bis(2,4-dimethyl)(1,3-pentadienyl)titanium, titanium tetrachloride, titanium tetrabromide, titanium tetraiodide, and cyclopentadienylcycloheptatrienyltitanium." Each of these precursors includes **no** nitrogen. Therefore, it is not possible to use these gases as the titanium and nitrogen precursor as stated in claim 76.

Claim 91 recites the limitation of forming the using a titanium precursor "selected from the group consisting of precursor of the formula $Ti(NR_2)$, where R is selected from the group

consisting of one or more of hydrogen, an alkyl group and an aryl group, tetrakisdiethylamidotitanium, bis(2,4-dirnethyl)(1,3-pentadienyl)titanium [sic], titanium tetrachloride, titanium tetrabromide, titanium tetraiodide, and cyclopentadienylcycloheptatrienyltitanium." This limitation does not make sense as written because, for example, there are no such compounds that consist of $TiNR_2$ wherein R is titanium tetrachloride.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 75-85 and 88-91 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ovshinsky et al. (US 6,087,674) in view of Russell (US 6,235,631) and Iyer (US 6,156,630).

Regarding claim 75, Ovshinsky discloses depositing a single layer (6,8) containing a first metal (titanium), aluminum, nitrogen and boron on a semiconductor substrate (10) (col. 9, ln. 44 – col. 10, ln. 5). Ovshinsky does not disclose what method is used to deposit this layer. Russell discloses depositing a thin film Ti-Al-N layer on a semiconductor substrate. Russell states that it is known in the art to use PVD techniques to deposit this type of a film but this deposition process results in poor film quality and poor step coverage (col. 1, ln. 48-66). Russell teaches a CVD method of depositing a Ti-Al-N film that produces a film having good step coverage and good quality (col. 2, ln. 11-26). The CVD method involves placing the wafer into a CVD

chamber, heating the wafer and introducing a metal (titanium) precursor, an aluminum precursor and a nitrogen precursor into the chamber to simultaneously deposit the Ti-Al-N layer. At the time of the invention, it would have been obvious to one of ordinary skill in the art to form the Ti-Al-B-N film of Ovshinsky by the CVD process of Russell because Ovshinsky does not teach any particular deposition process and Russell teaches a CVD process that results in a good quality and good step coverage film. Neither Ovshinsky nor Russell teaches how to incorporate boron into the Ti-Al-B-N film. Iyer teaches a method of depositing a titanium boride layer on a semiconductor substrate. Iyer teaches that this layer may be successfully deposited by using a CVD process in which a boron precursor is introduced into the CVD chamber along with the titanium precursor (col. 7, ln. 3 – col. 8, ln. 22). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the CVD method of Iyer to incorporate the boron into the titanium-containing layer of Ovshinsky because Ovshinsky does not teach any particular method of incorporating boron into the layer, Russell teaches that CVD processes are advantageous, and Iyer teaches that boron can be successfully incorporated into a titanium-containing layer by using CVD.

Regarding claim 76, Russell discloses that a single gas serves as the titanium precursor and the nitrogen precursor (Abstract).

Regarding claims 77, 79 and 91, Russell discloses that the titanium and nitrogen precursor is $Ti(N(CH_3)_2)_4$ (tetrakis-dimethyl-amido-titanium) (Abstract).

Regarding claim 78, Russell discloses heating the wafer to a temperature of 200-500°C (Abstract).

Regarding claims 80 and 90, Russell discloses that the aluminum precursor is dimethylaluminumhydride (DMAH) (Abstract).

Regarding claim 81, Iyer discloses that titanium tetrachloride ($TiCl_4$) can be used to successfully deposit a titanium-containing layer via a CVD process.

Regarding claim 82, Russell discloses that the metal (titanium) precursor can be an organometallic compound.

Regarding claim 83, Iyer discloses that the boron precursor is a boron reactant gas.

Regarding claims 84 and 85, Russell discloses that the nitrogen precursor is a nitrogen reactant gas.

Regarding claim 88, Ovshinsky discloses depositing a layer (6,8) containing a first metal (titanium), aluminum, nitrogen and boron on a semiconductor substrate (10) (col. 9, ln. 44 – col. 10, ln. 5). Ovshinsky does not disclose what method is used to deposit this layer. Russell discloses depositing a thin film Ti-Al-N layer on a semiconductor substrate. Russell states that it is known in the art to use PVD techniques to deposit this type of a film but this deposition process results in poor film quality and poor step coverage (col. 1, ln. 48-66). Russell teaches a CVD method of depositing a Ti-Al-N film that produces a film having good step coverage and good quality (col. 2, ln. 11-26). The CVD method involves placing the wafer into a CVD chamber, heating the wafer to a temperature of 200-500°C, establishing a pressure of 0.1 to 25 torr within the reactor, and injecting an organometallic (titanium) precursor and an aluminum precursor into the reactor. At the time of the invention, it would have been obvious to one of ordinary skill in the art to form the Ti-Al-B-N film of Ovshinsky by the CVD process of Russell because Ovshinsky does not teach any particular deposition process and Russell teaches

a CVD process that results in a good quality and good step coverage film. Neither Ovshinsky nor Russell teaches how to incorporate boron into the Ti-Al-B-N film. Iyer teaches a method of depositing a titanium boride layer on a semiconductor substrate. Iyer teaches that this layer may be successfully deposited by using a CVD process in which a boron precursor is introduced into the CVD chamber along with the titanium precursor (col. 7, ln. 3 – col. 8, ln. 22). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the CVD method of Iyer to incorporate the boron into the titanium-containing layer of Ovshinsky because Ovshinsky does not teach any particular method of incorporating boron into the layer, Russell teaches that CVD processes are advantageous, and Iyer teaches that boron can be successfully incorporated into a titanium-containing layer by using CVD.

Regarding claim 89, Ovshinsky discloses depositing a conformal layer (6,8) containing a first metal (titanium), aluminum, nitrogen and boron on a semiconductor substrate (10) (col. 9, ln. 44 – col. 10, ln. 5). Ovshinsky does not disclose what method is used to deposit this layer. Russell discloses depositing a thin film Ti-Al-N layer on a semiconductor substrate. Russell states that it is known in the art to use PVD techniques to deposit this type of a film but this deposition process results in poor film quality and poor step coverage (col. 1, ln. 48-66). Russell teaches a CVD method of depositing a Ti-Al-N film that produces a film having good step coverage and good quality (col. 2, ln. 11-26). The CVD method involves placing the wafer into a CVD chamber, heating the wafer to a temperature of 200-500°C, establishing a pressure of 0.1 to 25 torr within the reactor, and injecting an organometallic (titanium) precursor and an aluminum precursor into the reactor. At the time of the invention, it would have been obvious to one of ordinary skill in the art to form the Ti-Al-B-N film of Ovshinsky by the CVD process of

Russell because Ovshinsky does not teach any particular deposition process and Russell teaches a CVD process that results in a good quality and good step coverage film. Neither Ovshinsky nor Russell teaches how to incorporate boron into the Ti-Al-B-N film. Iyer teaches a method of depositing a titanium boride layer on a semiconductor substrate. Iyer teaches that this layer may be successfully deposited by using a CVD process in which a boron precursor is introduced into the CVD chamber along with the titanium precursor (col. 7, ln. 3 – col. 8, ln. 22). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the CVD method of Iyer to incorporate the boron into the titanium-containing layer of Ovshinsky because Ovshinsky does not teach any particular method of incorporating boron into the layer, Russell teaches that CVD processes are advantageous, and Iyer teaches that boron can be successfully incorporated into a titanium-containing layer by using CVD.

Claim 86 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ovshinsky et al. (US 6,087,674) in view of Russell (US 6,235,631) and Iyer (US 6,156,630) as applied to claim 75 above, and further in view of Sandhu et al. (US 6,313,035).

Regarding claim 86, Ovshinsky, Russell and Iyer do not disclose the structure of the CVD apparatus used to deposit the Ti-Al-N layer. Sandhu discloses using a CVD process to deposit a titanium-containing layer from a TDMAT precursor. Sandhu states that in order to form a titanium-containing layer having good film uniformity, a carrier gas is used to vaporize and transport the TDMAT precursor in a bubbler (col. 6, ln. 42-62). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use a bubbler to provide the titanium precursor because Russell discloses using a TDMAT precursor to CVD deposit the

titanium-containing layer and Sandhu states that by providing a carrier gas with the TDMAT in a bubbler, a titanium-containing film having good uniformity can be formed.

Claim 87 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ovshinsky et al. (US 6,087,674) in view of Russell (US 6,235,631) and Iyer (US 6,156,630) as applied to claim 75 above, and further in view of Murzin et al. (US 6,117,772).

Regarding claim 87, Ovshinsky, Russell and Iyer do not disclose the structure of the CVD apparatus used to deposit the Ti-Al-N layer. Murzin discloses using a CVD process to deposit an aluminum-containing layer from a DMAH precursor. The successful deposition of the aluminum-containing layer involves using a direct liquid injection system to provide the aluminum precursor to the substrate (col. 10, ln. 1-19). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use a direct liquid injection system to provide the aluminum precursor because Russell discloses using a DMAH precursor to CVD deposit the aluminum-containing layer and Murzin states that by providing the DMAH precursor to the CVD chamber by way of a direct liquid injection system, an aluminum-containing film can be successfully deposited.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christy L. Novacek whose telephone number is (571) 272-1839. The examiner can normally be reached on Monday-Thursday and alternate Fridays 7:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (571) 272-1852. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CLN
July 25, 2004

AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800